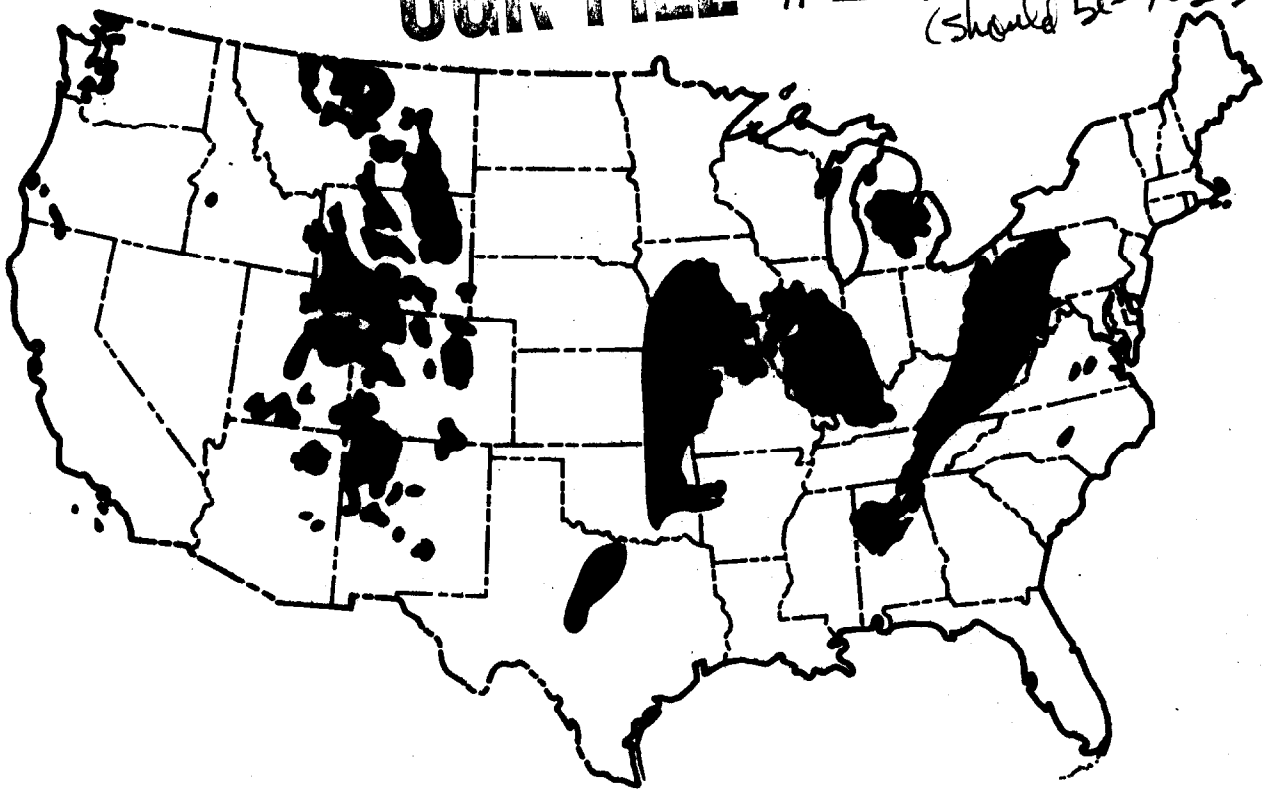
UGR- #102

Methane Recovery from Coalbeds Project

Resource Engineering Workshop Minutes



Denver, Colorado — January 21-22, 1981

Prepared for
United States Department of Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
TRW Energy Engineering Division

MINUTES OF THE
METHANE RECOVERY FROM COALBEDS PROJECT
RESOURCE DELINEATION WORKSHOP

January 21-22, 1981

Sponsored by

United States Department of Energy
Morgantown Energy Technology Center
Morgantown, West Virginia 26505

INTRODUCTION & SUMMARY

The Methane Recovery from Coalbeds Project (MRCP) Resource Engineering Workshop has been held in Denver, Colorado each January since 1978 for the purpose of bringing together people involved in the resource delineation activities of the project. For the first two years, the emphasis of the workshop had been to promote interaction among geotechnical professionals directly involved in MRCP resource delineation activities, to provide an opportunity to discuss significant progress and identify critical issues and problems. This year, invitations were extended to other companies who have expressed an interest in developing their own methane recovery and utilization programs in an attempt to foster commercial and industrial exploitation of the resource, such as gas companies and coal operators. Thus, participants at the workshop included representatives from eleven oil and gas operators, three coal companies, and three organizations interested in developing independent alternative sources.

At the same time, in order to encourage widespread participation in technical discussions, DOE and their integrating contractor, TRW, developed a new format for the workshop. The revised format featured the following:

- An opening meeting, moderated by Mr. Leo A. Schrider, Assistant Director of the DOE Morgantown Energy Technology Center. Mr. Schrider introduced, in turn:

  - Mr. Jeffrey B. Smith, Assistant Director of the DOE Unconventional Gas Recovery (UGR) Program, who briefly discussed the UGR program and the goals and objectives of the various projects

  - Mr. John R. Duda, Manager of MRCP, who discussed the project; its goals and objectives; some of the more significant accomplishments in R&D, resource delineation, and technology test projects; and future needs.

- Four separate discussion topics were proposed, and attendees were invited to participate in the discussion of their selection. The four topics, and selected discussion leaders were:

  - Stimulation - Dr. Harold D. Shoemaker, DOE, Project Manager, UGR Drilling Technology Project

- Completion - Mr. Norman F. McGinnis, TRW, Assistant Project Manager for Engineering, Coalbed Methane Projects

- Exploration and Testing - Mr. Craig T. Rightmire, TRW, Assistant Project Manager for Resource Engineering, Coalbed Methane Projects

- Production Prediction - Mr. Ken Ancell, INTERCOMP, Manager of Gas Projects

- A closing session moderated by Leo Schrider. The session consisted of summarization of the individual session by the discussion leaders. Since only two people had expressed an interest in discussion of well completion, the topic was combined with the session on Stimulation and led jointly by Harold Shoemaker and Norm McGinnis.

The 1½ day workshop was held at the Holiday Inn (West) in Golden, Colorado on January 21 and 22. The closing section was held on the second day in a meeting of all the participants.

The MRCP Resource Delineation Workshop '81 was attended by a total of 65 representatives from 38 separate organizations or branches of organizations. As stated earlier, attendance included representatives from eleven oil and gas companies, three coal companies, and three others interested in developing their own methane recovery and utilization programs. A roster of the attendees compiled from the registration cards, is included on pages 23 through 26. The workshop composition, by industry or sector affiliation, was as follows:

Industry or sector	No. of people
Oil and gas	19
Coal	4
Other CH_4 development interests	8
Industry CH_4 research support*	21
Federal government*	8
State government	5
Total	65

*Includes workshop moderator, discussion leaders and writers.

The minutes and the view graphs prepared by the groups and presented by the discussion leaders at the closing session on Friday morning, follow this section.

This workshop was not intended to arrive at a concensus on points of discussion. Rather, it was intended to foster communication between the sponsoring agency, DOE; project participants; and the general public. To that end, much of the information obtained at the workshop will be useful in planning future MRCP activities in Resource Engineering, Production Technology Development. and R&D. The findings of the three individual sessions are documented on summary charts starting on page 14 of this document.

Comments concerning the workshop are invited. Please send written comments concerning recommendations for discussion topics, items of concern, etc. to:

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DOE METHANE RECOVERY FROM COALBEDS PROJECT

Resource Engineering Workshop

Minutes of the Working Sessions on Stimulation and Well Completion

Harold Shoemaker, METC and N. F. McGinnis, TRW, Co-Moderators

The Stimulation and the Well Completion discussion groups were combined, due to the fact that only two people had signed up to participate in discussions on well completion techniques (state-of-the-art and required additional research). Harold Shoemaker asked the participants to rise, introduce themselves, and briefly state their association and interest or role in methane recovery from coalbeds.

Discussion of various topics was, in each case, initiated by a question on a comment from the moderator or one of the other attendees. The questions and pertinent discussion are paraphrased in these minutes.

Question: What are the causes of poor frac results?

- Lack of understanding of the methane reservoir
- Lack of understanding of effects of multiple well patterns
- Research in proppant usage is still incomplete
- In pumping frac fluid, our concerns are with containment of the frac but not with the fluid leakoff.

Question: Do older fractures close out?

- We do not have data that addresses this problem primarily because all of the minethrough operations have involved shallow wells.

Question: How can we tell whether or not a frac has been successful?

- If flow becomes a concern, injectivity tests should be applied
- Generally, flow of anything is a good sign that fracture has been successful.

Question: Are current computerized fracture design programs adequate for coalbed methane?

- There are no frac design programs for coalbeds
- Design of coalbed fracs (single- or multi-well) are generally dictated by economics.

Question: How does production from horizontal boreholes (from surface) compare with production from fractures vertical wells?

- Emerald Mines project is one example of horizontal boreholes from the surface. However, we have had no success in dewatering it.
- Current plans are to test the communication between the wells in the pattern.

Question: Has anyone had good experience with frac fluid additives? Is this a research need?

- Additives used to stop leakoffs have also acted as a deterrent to flowback, so its use is being avoided by some of the well service companies.

Question: Has anyone tried to determine the effect of water on coal?

- No.

Question: What about other fluids?

- No.

Question: What is the aim of a frac - do we always want to stay in the coal seam? Do we want to frac the roof and/or floor rock?

- Probably depends on your eventual mining intent. If you are going to mine the coal, you would try to avoid roof damage. Also, if an aquifer exists above the roof rock you would not want to disturb it.

Question: What instrumentation technology do we need to develop to aid in applying stimulation treatments?

- None identified.

Question: Do we need to do more work in coal geometry?

- We need to look at in situ stress
- Analytic and correlation techniques need to be developed. A relaxed stress pattern needs to be used to do those tests.

Question: Gelled frac fluids - what does it really contribute?

- Experience in breakdown time has not been good when compared with other fluids
- No idea as to what the chemicals are doing to the coal.

Comment: Algas has had significant production from wells of 150 to 200 feet.

Summary Comments

- We know a lot about coal but have not transferred the technology to the field. For example when service companies design coal frac jobs, the computations are based on sandstone or other reservoir rock, rather than on coal.
- On the other hand, we still do not understand coal characteristics completely, such as its in situ reaction to stress.
- However, adequacy of the technology is not as much a problem, as adaptation of the technology developed to real world applications.

The last 90 minutes of the afternoon session were spent in preparing the view graphs to be presented by the discussion co-moderators, Harold shoemaker and Norm McGinnis, at the closing session. The discussion was not separately recorded.

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DOE METHANE RECOVERY FROM COALBEDS PROJECT

Resource Engineering Workshop

Minutes of the Working Session on Exploration and Testing

C. T. Rightmire, TRW, Inc., Moderator

Morning Session - Exploration

The session was started with a brief description of the workshop and the need to address two primary objectives. The first objective was to ascertain the adequacy of the technology used in the exploration and testing for coalbed methane, and the second was to address the areas where research and development may be needed.

The general discussion was started by Rightmire with the question of what criteria are necessary for site selection for coalbed methane prospects. Coal, methane content, production potential, as well as rank and depth should be considered important. It was suggested that site selection may be too broad to define. A number of questions were raised on this point. The peaks in biogenic and thermal processes, trapping mechanisms, hydrodynamics and stratigraphy, the origin of the gas, depositional history and fractures were suggested as areas where more information was required. One exploration strategy suggested was to merge the Tight Sands Project with the coal program as there appears to be many mutual problems.

The need for a better desorption technique was discussed. A continuous monitoring system for gas volume and tests for gas quality and composition would be most valuable. European methods and equipment for this may be available soon. Some work with chip desorption is being done at the University of New Mexico, and a balanced closed system which can measure negative pressure has been developed and is in limited use by TRW. Cuttings may also be useful for reflectance studies and tied in with the mud logs.

The usefulness of DST's in coalbed methane evaluation is debatable. Low pressures, difficulty in making estimates of gas content, and the lack of success, particularly in the east, were some of the problems in utilizing

this test procedure. Noise and temperature logs were suggested as being more pragmatic.

The value of stimulation for production was questioned. The swelling of coal with water, marked in some ranks, is a problem that needs additional study. However, the release of residual gas may require some form of stimulation.

Afternoon Session

Exploration

The afternoon session began with the question of how to set up an exploration program. Is there some information or data that can be used to convince management that drilling for coalbed methane is a good idea was raised as an important priority. The following points were made:

- Reserve economics and recoverable estimates are not basically known. Value of 200 cf/ton with 1,800 tons/acre-foot and 60 percent recovery have been suggested. Empirical data from documented production is lacking. Average values are difficult to apply regionally. A data base must be established.

- A suggestion was made that management should be convinced to explore coal that is encountered in deeper target wells. Valuable information is presently lost and the potential to make money from coal is documented. There is more gas per cubic foot in coal than in sandstone.

With regard to exploration, a number of salient points were made and several questions raised.

- Exploration techniques for coalbed methane are basically the same as for oil. An exploration history is lacking, but case histories of documented production wells may provide valuable information.

- Exploration strategy must include the gas origin. There is a need for an isotope study to help determine the gas origin.

- It is conceivable there may be two productive horizons, a shallow zone and deeper coals (5,000 to 10,000 feet). This may require two different approaches and different economic assessments.

- There can be data derived from the reevaluation of old holes in an area, and an attempt to do this should be made.

The questions raised on exploration were:

- What are the federal constraints? For example, who owns the gas?
- Is the 3,000-foot depth limit of the USGS real or arbitrary?
- What is a realistic fracing depth?
- Is there interest in degassing for mining or for gas production?
- What percent of the economics is controlled by the water problem?
- Is the anticlinal theory applicable?

Testing

Discussion on the exploration was terminated and turned toward testing procedures that may be applicable to coalbed methane. Interference testing for formation permeability, determination of well spacing, and the influence of the cleat structure would add considerable information to a data base. Drill stem testing can be useful but should incorporate only the seam being tested. A well engineered DST may be the best method of gathering information.

In an exploratory program, standard core desorption should be the first test procedure. If the results are good, then other tests should be performed. Logging is a good tool, particularly the SP curve for water saturation, and a high resistivity for high gas content.

Summation

The final hour of the session was devoted to summarizing the discussions held during the day. The results of that discussion are:

Exploration

- Oil and gas techniques are in part applicable--needs development for coal.
- Borehole geophysical techniques adequate only for locating coal zones.
- Prediction of coal gas content is adequate but needs improvement as well as other methods.
- Develop production data.
- Coal characterization is inadequate.

R&D

- Is it feasible to develop a wire line technique.
- Indicators of gas in coal.
- Calibrated mud log.
- Accelerate resource delineation program.
- Need for hard data to show relationship between geology and coal gas (more wells).

Questions

- How can one relate gas content with productivity?

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DOE METHANE RECOVERY FROM COALBED PROJECT

Resource Engineering Workshop

Minutes of Working Session on Production Prediction

Ken Ancell, INTERCOMP, MODERATOR

Discussions were conducted in two basic areas:

1. The conceptual model, and
2. Input parameters to the model.

The salient topics of discussion are summarized below.

The Conceptual Model

The session was initiated by an informal tutorial discussion of the mechanism by which methane is stored in a monomolecular layer on the carbon in coal in a state of pressure equilibrium. In a water saturated system following reduction of hydrostatic pressure the methane and other gases desorb from the coal matrix via a two-phased Darcy flow. The time required to desorb gas from the coal is a function of the diffusion coefficient which is a function of the crystal matrix and the area of the assumed spherical material. Topics and answers to questions related to the conceptual model were:

- From 60% to 75% of the measured gas can be recovered from coal.
- Specific gas content is determined by the "direct" method, and time required to determine gas content by this method is approximately two months. Measurement errors are systematic in that any lost gas or mechanical damage to the desorption sample results in a lower than in situ indication. The analysis method developed by Geochem requires only two days, and results matched those obtained by the direct method.
- Large cores are the preferred coal sample, and in British Columbia cores up to six inches in diameter are obtained.
- In response to a question regarding the energy of desorption, it was stated that the effects were very small and are ignored in the model. Attendees were advised that the model is described in the MRCP Resource Delineation Plan.

- In response to questions regarding the effect of other gases on transport of methane, it was stated that CO_2 displaces methane preferentially. Additionally, other gases are present only in small quantities and are ignored in the model.

- Immobility of water has not been observed.

- Desorption predictions are based on radial flow.

Important Parameters

The most critical parameters effecting transport of methane from the coal matrix are:

- Permeability

- Pressures

- Relative Permeability

- Sorption isotherm

- Fracture length

- Fracture conductivity

Items and questions related to input parameters were:

- Great discrepancies between the direct method and adsorption isotherm method were discussed. The moderator indicated that the process should be reversible and free of hysteresis and that results obtained via the direct method were probably due to unaccounted for lost gas.

- Gas production is apparently dependent on the lowest permeability.

- US Steel is currently developing a model that accounts for boundary conditions existing at the mine face.

- In response to questions pertaining to drill stem testing, it was stated that the best results are obtained after cleaning and by conducting the test in reverse.

- The pros and cons of using CO_2 injection to stimulate methane flow was discussed. Limited (laboratory) work has been done on this concept.

- Concern was expressed that chemicals used in stimulation could damage the coal chemically. Even though the volume may be insignificant, coal buyers could be scared off by traces of contaminants.

- The concept of directional drilling as an alternative to hydrofracing was discussed. The DOE has done some work in this area, but funding for this work is being eliminated.

- Verifications or correlations of the model developed under DOE contract is very limited.

- The attendees concurred with the view that a well pattern is much more likely to produce gas than a single well since interference between wells is required to increase the cone of depression. The moderator stated that only the gas inboard of a well pattern is drained.

- Questions regarding damage of wells by water buildup were addressed. No consensus was reached on these concerns.

- Concerns regarding damage of the mine roof by hydraulic stimulation were addressed. No consensus was reached on this subject.

- Empirical prediction techniques were discussed to a very limited extent with the moderator indicating they are valid.

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MRCP RESOURCE DELINEATION WORKSHOP '81

STIMULATION/COMPLETION

- ADEQUACY OF TECHNOLOGY
  - FRAC DESIGN CAPABILITY IS NOT SATISFACTORY FOR STIMULATING COAL SEAMS
    - WE DON'T KNOW ENOUGH ABOUT THE COAL SEAM AS A CH_4 PRODUCER (WE DON'T UNDERSTAND IT!)
    - ASSUMPTIONS FOR CRITICAL DESIGN PARAMETERS.

MRCP RESOURCE DELINEATION WORKSHOP '81

EXPLORATION & TESTING

- ADEQUACY OF TECHNOLOGY

  - IN GENERAL, OIL & GAS TECHNOLOGIES ARE APPLICABLE, NEED DEVELOPMENT FOR COAL

  - BOREHOLE GEOPHYSICAL TECHNIQUES ARE ADEQUATE ONLY FOR LOCATING COAL ZONES

  - PREDICTION OF COAL GAS RESERVOIR DISTRIBUTION IS ABOUT AS RELIABLE AS FOR OTHER RESERVOIRS

  - REQUIRE THE DEVELOPMENT OF PRODUCTION DATA

  - COAL CHARACTERIZATION IS INADEQUATE.

MRCP RESOURCE DELINEATION WORKSHOP '81

PRODUCTION PREDICTION

- ADEQUACY OF TECHNOLOGY

  MODELS HAVE BEEN DEVELOPED

  - NARROW RANGE OF VALIDATION
  - FIELD VALIDATION OF BOUNDARY EFFECTS NEEDED

  MEASUREMENT OF IMPORTANT PARAMETERS

  - EXISTING EQUIPMENT (OIL & GAS) GENERALLY ADEQUATE
  - PROCEDURES NEED FURTHER DEVELOPMENT.

MRCP RESOURCE DELINEATION WORKSHOP '81

STIMULATION/COMPLETION

- R&D NEEDS
  - WHAT CONTROLS FRAC GEOMETRY?
  - WHICH COMPLETION TECHNIQUE BEST ADAPTED TO THE GEOLOGY?
  - LEAK OFF CONTROL W/O COALBED DAMAGE
  - CHEAP METHOD FOR IN-SITU STRESS DETERMINATIONS
  - WHAT ARE THE COALBED RESERVOIR PARAMETERS
  - DESIGN CHEAP STIMULATION TECHNIQUE BY RAISING THE TEMPERATURE OF COALBED
  - DEVELOP NEW ALTERNATE STIMULATION TECHNIQUES (CHEAP, EASE OF APPLICATION, EQUAL OR BETTER EFFECTIVENESS
  - STIMULATION FLUID COMPATIBILITY W/COAL.

MRCP RESOURCE DELINEATION WORKSHOP '81

EXPLORATION & TESTING

- R&D NEEDS
  - IS IT FEASIBLE TO DEVELOP WIRELINE TECHNIQUES TO DETERMINE RELIABLY GAS AND/OR WATER SATURATION IN COALS
  - DEVELOP INDICATORS OF GAS IN COALS
  - DEVELOP CALIBRATED MUD LOGGING CAPABILITY
  - ACCELERATE THE RESOURCE DELINEATION PROGRAM
    - NEED MORE HARD DATA TO SHOW THE RELATIONSHIP BETWEEN GEOLOGY AND PRESENCE OF COALBED METHANE.

MRCP RESOURCE DELINEATION WORKSHOP '81

PRODUCTION PREDICTION

- R&D NEEDS
  - FIELD TEST CONTACTING COAL WITH CO_2
  - NEW WORK IN GAS CONTENT DETERMINATION
  - REFINE WELL TEST TECHNIQUES
  - MODEL DEVELOPMENT
    - EFFECTS OF MULTIPLE GAS COMPONENTS (CO_2, N_2, C_2H_6 ETC)
    - INCLUDED MINE DEVELOPMENT INTO MODEL
  - DEVELOP ALTERNATIVE TO HYDRAULIC FRACTURE
  - RISK ASSESSMENT.

MRCP RESOURCE DELINEATION WORKSHOP '81

STIMULATION/COMPLETION

- QUESTIONS
  - WE DO NOT KNOW WHETHER SOA STIMULATION TECHNIQUES ARE ADEQUATE FOR DEEP (> 2500 FT.) COAL SEAM TARGETS
  - CAN WE DEVELOP A CHEAP, SHORT TERM WELL PRODUCTION TEST TO DETERMINE IF STIMULATION IS REQUIRED?
  - IS TREATMENT VOLUME DESIGN SIZE A FUNCTION OF COALBED DEPTH?

MRCP RESOURCE DELINEATION WORKSHOP '81

EXPLORATION & TESTING

- QUESTIONS
  - ESTABLISH RELATIONSHIP BETWEEN GAS CONTENT AND GAS PRODUCIBILITY.

MRCP RESOURCE DELINEATION WORKSHOP '81

PRODUCTION PREDICTION

- QUESTIONS
  - INVESTIGATE EFFECTS OF COAL PETROLOGY ON THE COAL-GAS-WATER SYSTEM
  - INVESTIGATE POTENTIAL PROBLEM OF CHEMICAL REACTION OF FLUIDS WITH ASH COMPONENTS
  - INVESTIGATE POTENTIAL PROCESSES OF GAS DESORPTION.

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